Department of Conservation & Recreation

CONSERVING VIRGINIA'S NATURAL AND RECREATIONAL RESOURCES

Process

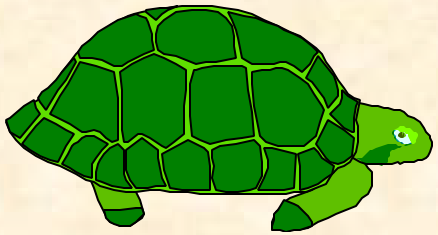
- TMDL study development
- Implementation plan development
- Implement the plan

The Concept of Modeling as a Tool

- Unsharpened pencil – very limited use
- Somewhat sharp pencil – limited use
- Very sharp pencil – very useful

Types of Nonpoint Source Impairments requiring TMDLs

- Fecal Coliform
- Aquatic Life Impacts
- Shellfish
- Others



Fecal Coliform

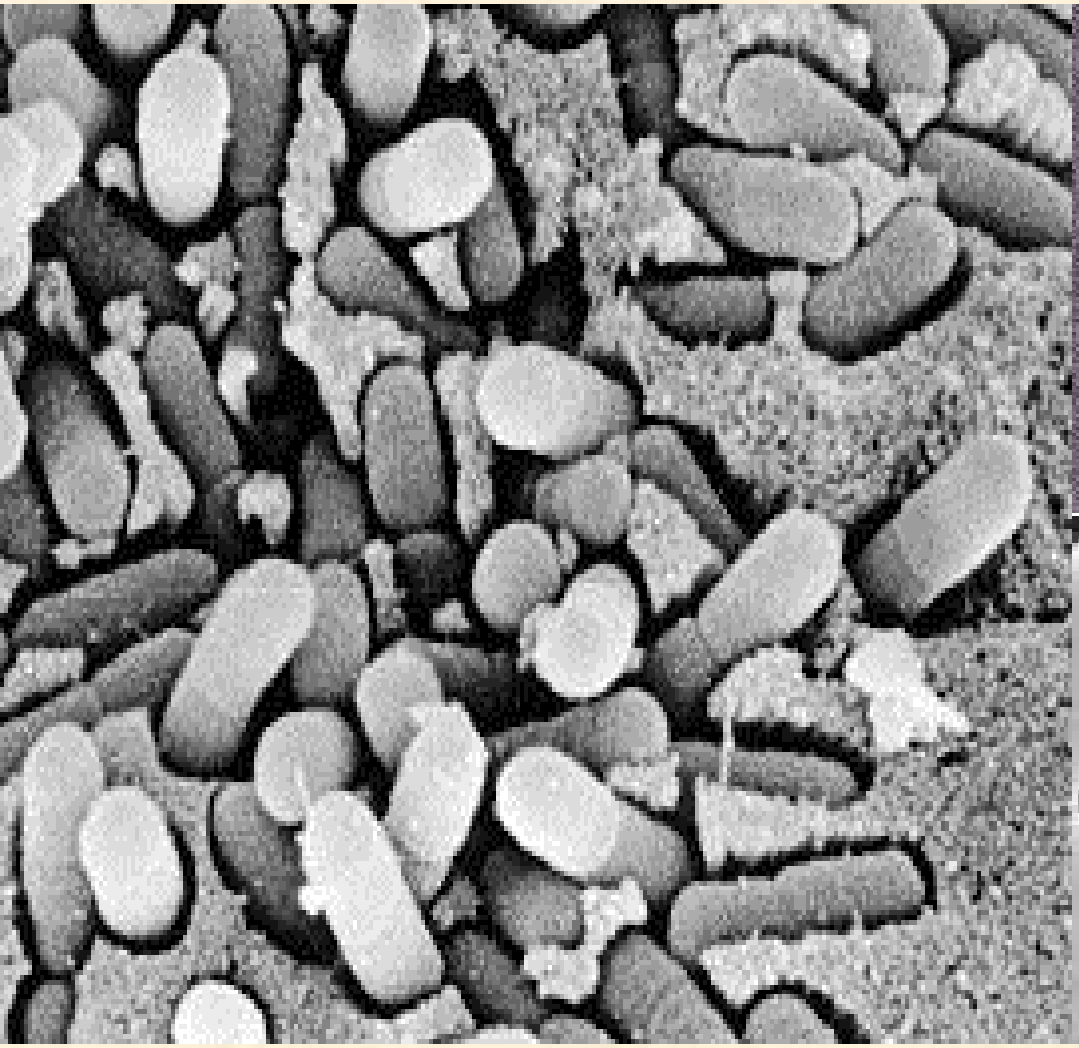
- At least 3 genera of fecal coliform. Most species are not considered to be pathogenic.

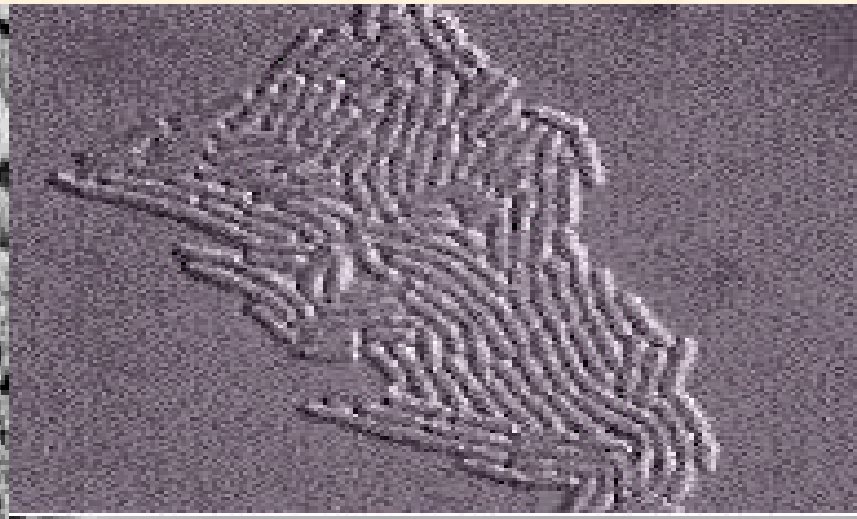
- *Escherichia coli* commonly called *E. coli*
- *Citrobacter*
- *Klebsiella*

Fecal Coliform

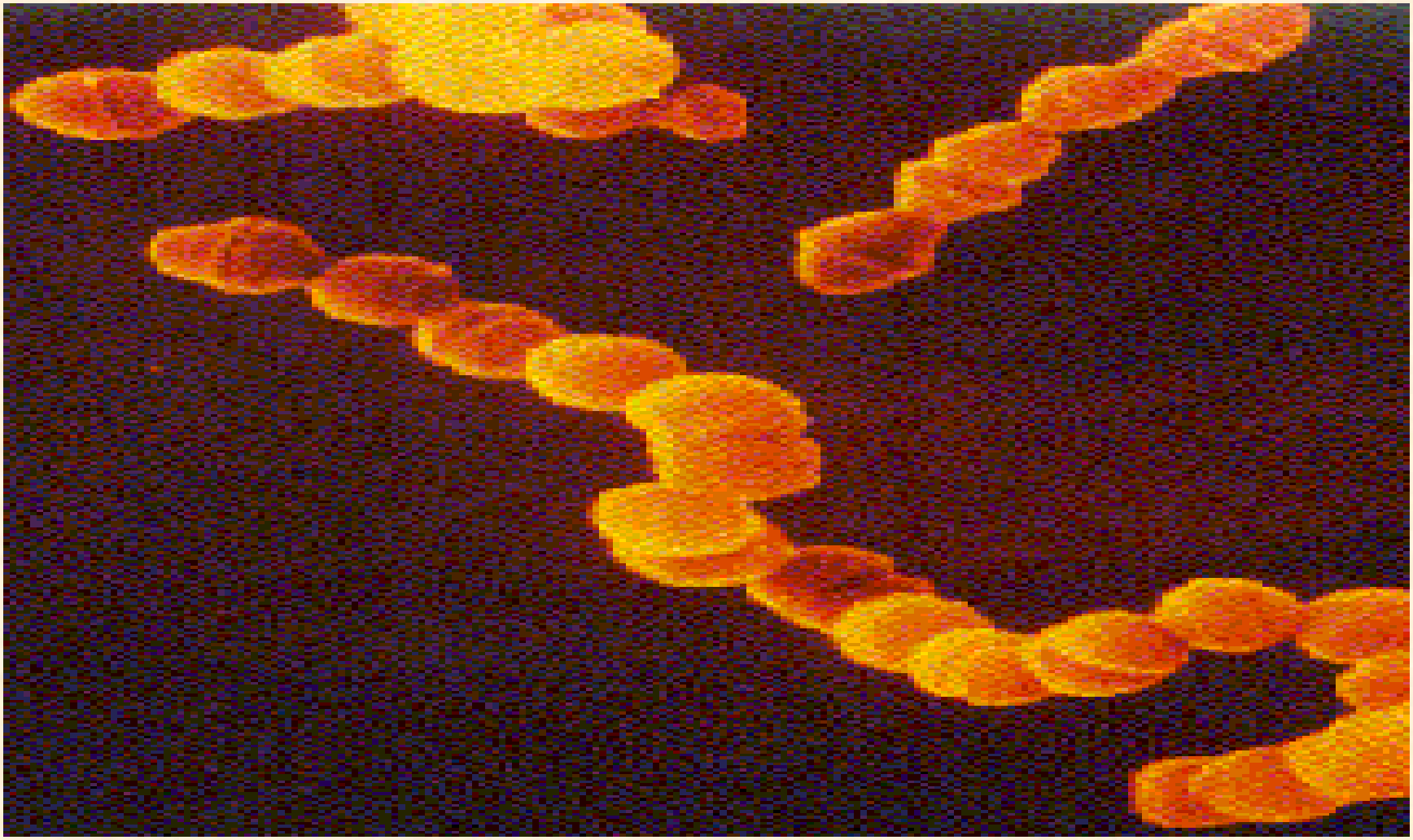
- Fecal Coliform bacteria are an indication of potential contamination from other fecal organisms.
- Fecal Streptococci/Enterococci
- Protozoan – Cryptosporidium, Giardia
- Virus – Norwalk, Polio
- Vibrio (cholerae, vulnificus)

Escherichia coli – E. coli

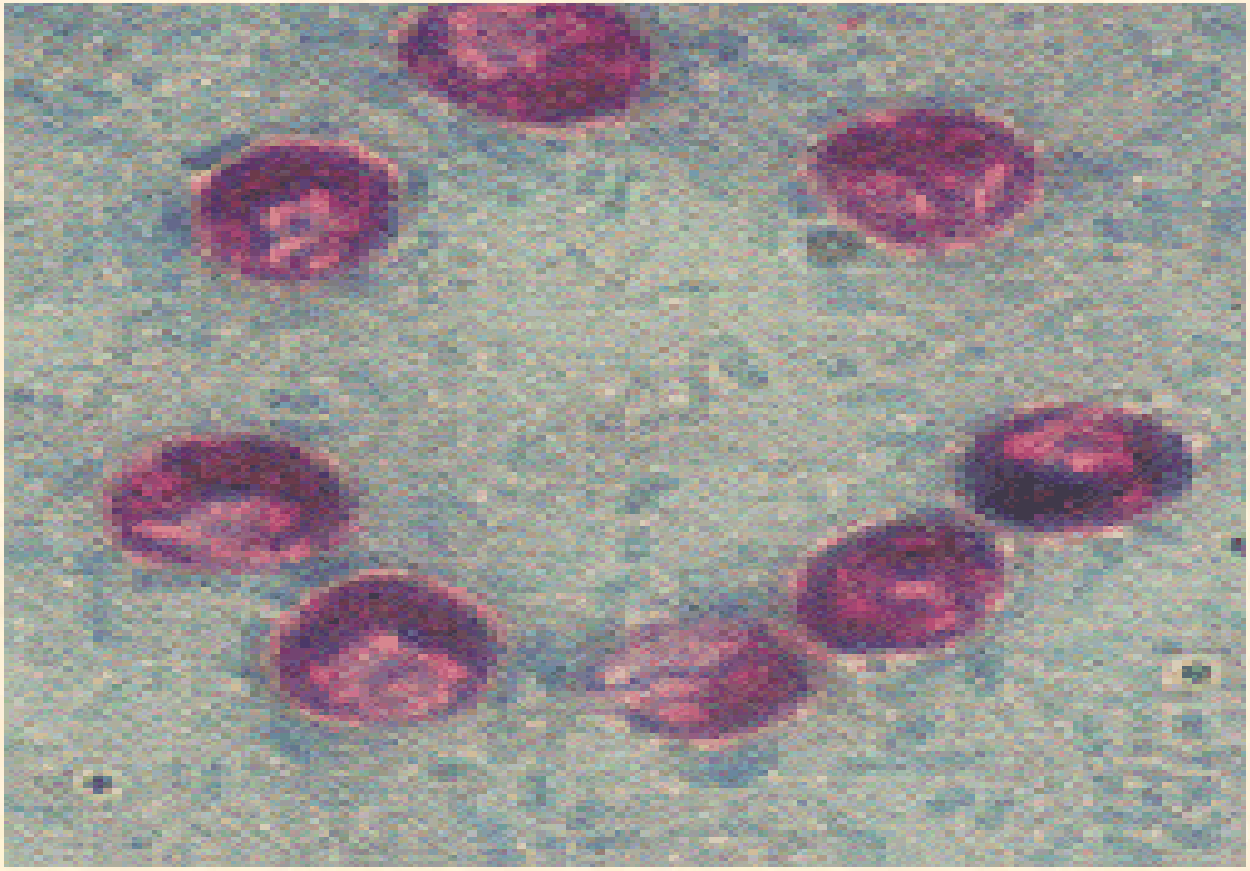




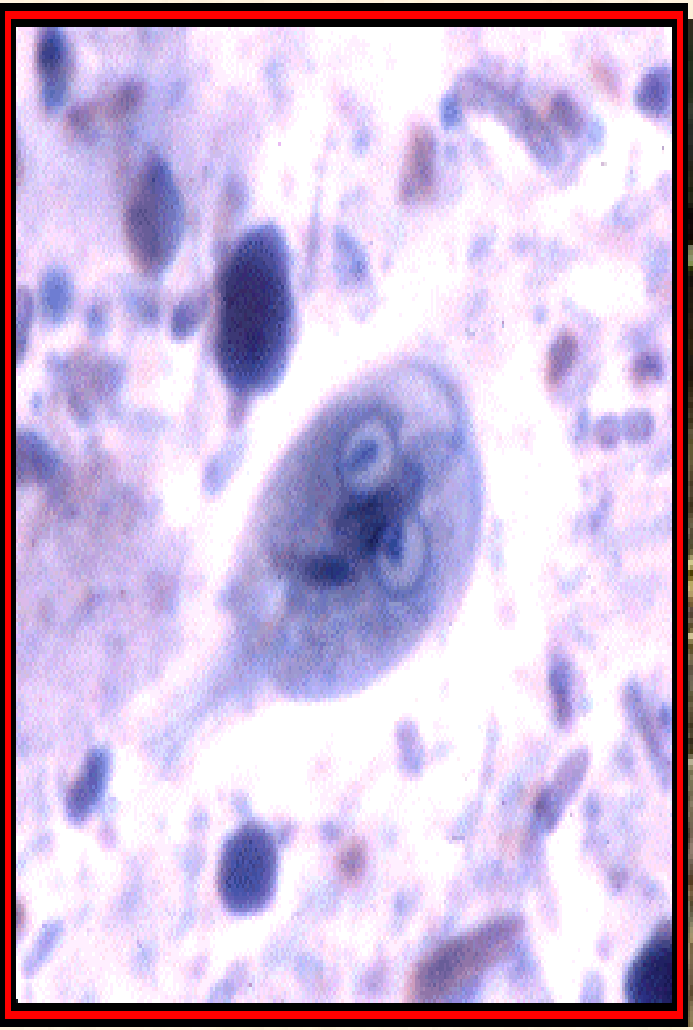
Fecal Streptococci/Enterococci



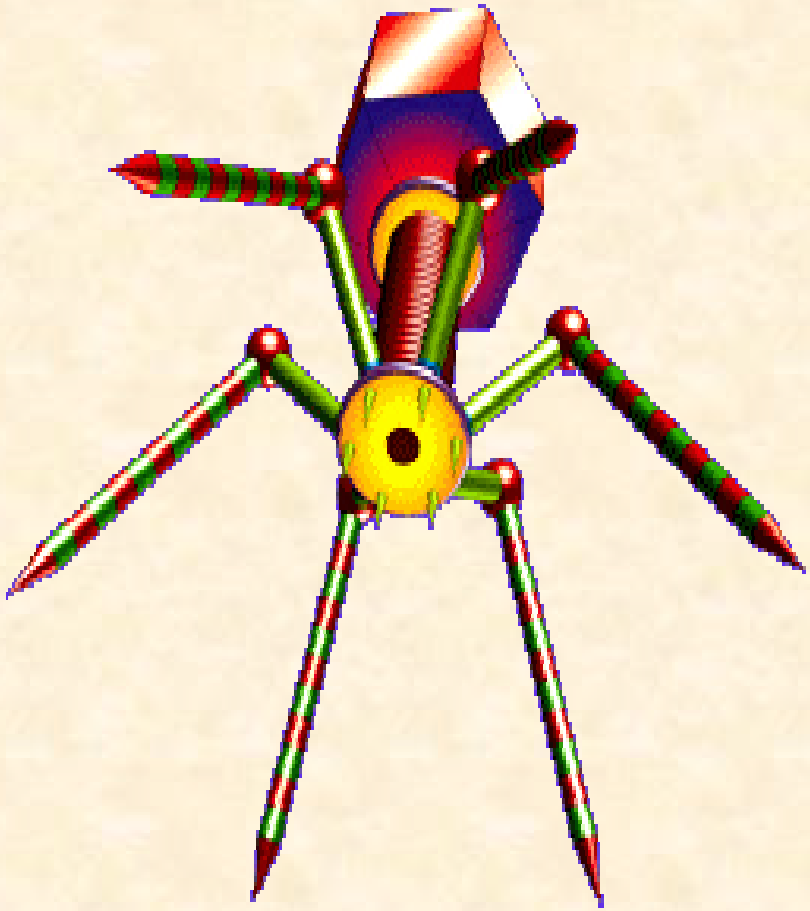
Protozoan – Cryptosporidium



Protozoan - Giardia



Virus



Bacteria Isolates

BACTERIA SOURCE TRACKING (BST)

- Molecular or genotypic
- Biochemical or phenotypic
- Chemical

BST Methods

- Biochemical or phenotypic looks for unique compounds or the effects of these compounds produced by *E. coli* or Enterococci that can be used to differentiate sources.

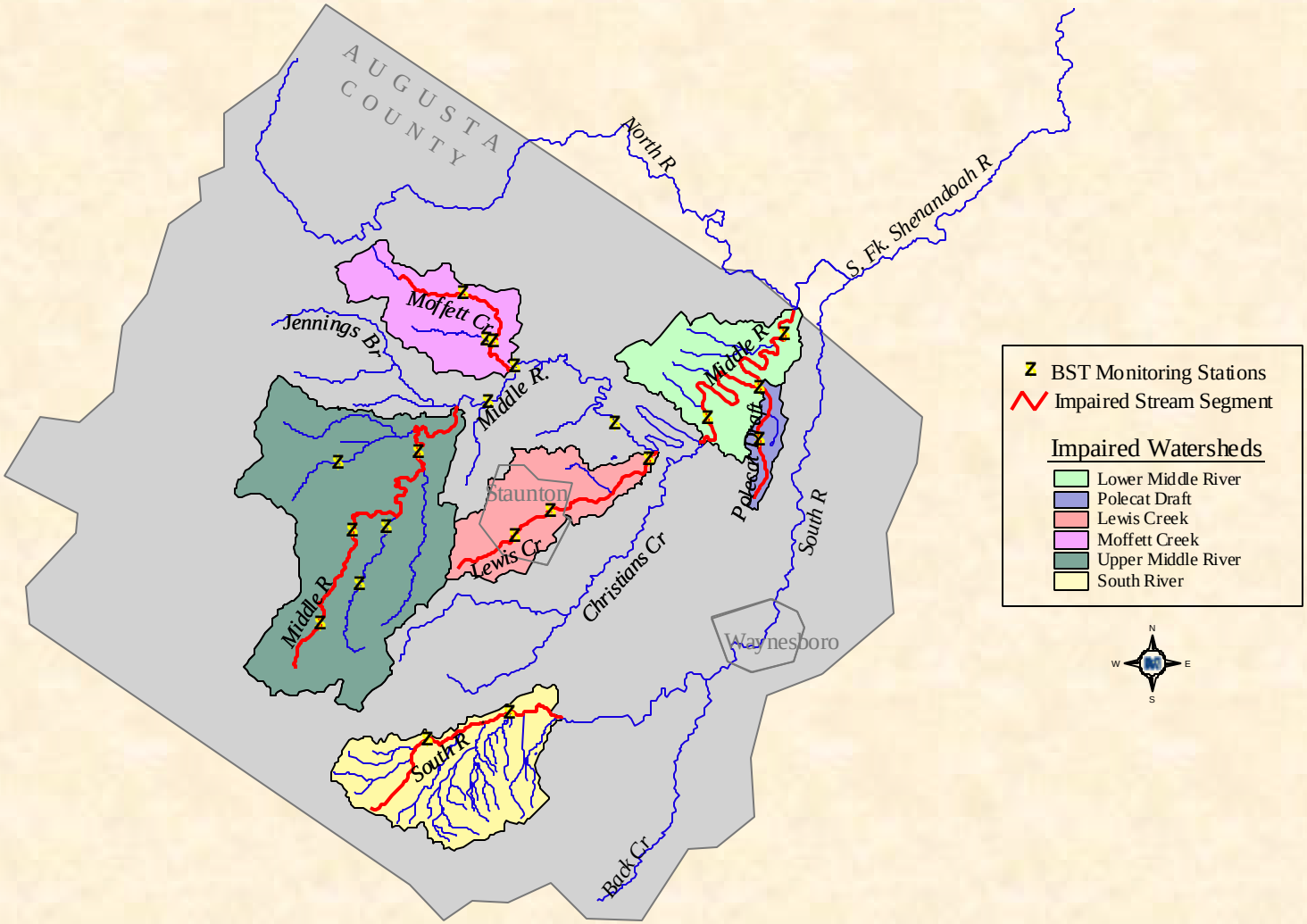
- Antibiotic Resistance Analysis (ARA)

How ARA works.

- The premise is that the fecal bacteria from different animals (species) have different degrees or patterns of antibiotic resistance to the battery of antibiotics and concentrations of these drugs used in the analysis. These patterns allow the clustering of animals into groups such as human, livestock or wildlife.
- If need be livestock can be separated into poultry or grazers.
- Wildlife can be separated into waterfowl (ducks and geese), deer, and aquatic mammals (beaver, muskrats, and raccoons).

Middle River

BST Monitoring Network



Data Needs for Fecal Bacteria TMDL

- **Agricultural Sources**
- Animal types, numbers, and location within the watershed.
- Livestock/Manure management (stocking densities, and typical storage capacity).
- Estimates on time livestock spend and amount of feces deposited in or near the streams.
- Cropping practices (conventional, no till, etc.).

Data Needs for Fecal Bacteria TMDL continued

- **Human Sources**
- Number, age, locations of septic systems.
- Number and location of homes connected to a sewer system.
- Biosolids land applications.
- Location and discharge data of sewage treatment works.
- Location of straight pipes.

Data Needs for Fecal Bacteria TMDL continued

- **Wildlife**
- Animal types, numbers, and location within the watershed.
- Estimates on time wildlife spend and amount of feces deposited in or near the streams.